

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau(43) International Publication Date
18 December 2003 (18.12.2003)

PCT

(10) International Publication Number
WO 03/105186 A2(51) International Patent Classification⁷:

H01L

(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(21) International Application Number: PCT/IB03/02712

(22) International Filing Date: 27 May 2003 (27.05.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
P.10225042.1 6 June 2002 (06.06.2002) DE

(71) Applicant (for all designated States except US): MARCONI COMMUNICATIONS GMBH [DE/DE]; Gerberstrasse 33, 71520 Backnang (DE).

(72) Inventor; and
(75) Inventor/Applicant (for US only): KERN, Stefan [DE/DE]; Merowinger Strasse 7, 68753 Waghäusel (DE).

(74) Agent: CAMP, Ronald; Marconi Intellectual Property, Marrible House, The Vineyards, Great Baddow, Chelmsford, Essex, CM2 7QS (GB).

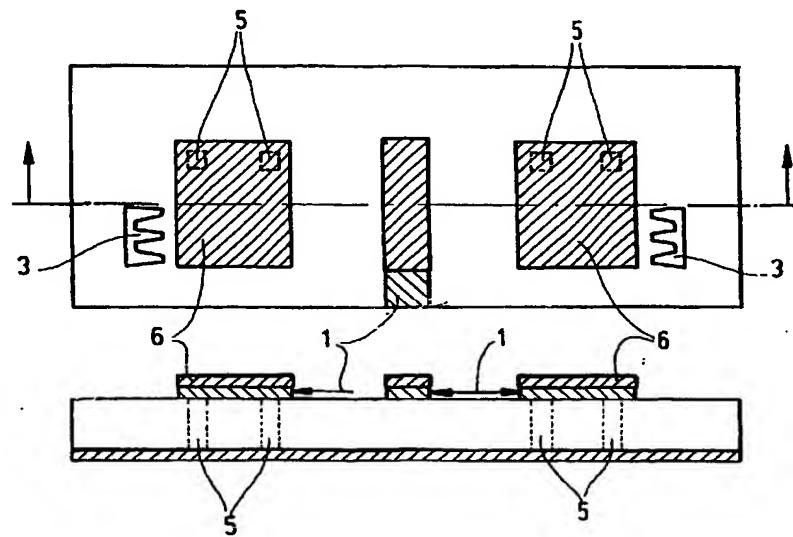
(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— without international search report and to be republished upon receipt of that report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: INTEGRATED CIRCUIT AND METHOD FOR MANUFACTURING SAME



WO 03/105186 A2

(57) Abstract: The invention relates to an integrated circuit having at least one microstrip line and at least one port, and to a method for manufacturing same, these being able to be used, in particular, for test passes for development purposes during chip production and also during chip manufacture. The invention provides for at least some of the ports and/or microstrip lines (1) in the integrated circuit to have a removable, reflection-free termination which is integrated on the chip. The inventive method provides for an integrated circuit to be produced in a first step, with at least some of the ports and/or microstrip lines (1) in the integrated circuit being provided with a removable, reflection-free termination which is integrated on the chip, and in a second step for this termination to be removed from a prescribable selection of the ports and/or microstrip lines (1) provided with the removable, reflection-free termination which is integrated on the chip.

Integrated circuit and method for manufacturing same

The invention relates to an integrated circuit and to a method for manufacturing same, which are able to be used particularly for test passes when developing radio-frequency circuits (RF circuits) and also in RF circuit manufacture.

Prior Art

10

Powerful communications technology and information technology currently plays a prominent role in all important areas of economy and science. A worldwide digital network which can be reached globally without restriction of location and allows individual access to information of all kinds is in the process of construction. Wireless (because they are mobile) communications systems are becoming increasingly important in this context.

20

Countless new services which use this technology, such as telemedicine and mobile data communication using laptops which are constantly connected to the network, are increasingly being used. Mobile information and communications systems will increase safety and mobility in road traffic, for example using vehicle anti-collision radar and satellite-aided navigation systems.

30

The result of development is that ever more powerful radio-frequency systems (RF systems) with a high bandwidth and increasing frequencies are becoming necessary. A few examples are mobile radio (0.9 and 1.8 - 1.9 GHz), satellite-controlled navigation systems (1.5 - 1.6; 12 and 14 GHz), WLANs (= Wireless Local Area Networks at 5.2 GHz), radio relay (for example 38 GHz for mobile radio base stations) and vehicle anti-collision radar at 77 GHz.

The constant introduction of new services which use radio-frequency technology (RF technology) therefore necessitates higher and higher frequencies, since the frequency bands used to date have in the meantime 5 become very densely occupied. As the frequency increases, however, the wavelength becomes shorter and shorter. As soon as the dimensions of a circuit or the elements thereof reach the order of magnitude of this wavelength, propagation time effects, in particular, 10 need to be taken into account when designing circuits. For this reason, attempts are being made to make the circuit dimensions smaller and smaller. This reduction in size is possible using monolithically integrated microwave circuits (MMIC = Microwave Monolithic 15 Integrated Circuits). With this technology, all the circuit elements required for manufacture are attached to a semiconductor material using thin-film technology in a plurality of processes. Since no hybrid elements, as in the case of the integrated microwave circuits 20 (MIC), are used, further miniaturization is possible. As compared with MICs, MMICs afford other advantages too. Thus, an MMIC circuit is much more reliable than an MIC circuit, since there are no subsequently attached components which could become detached. MMICs 25 have smaller production variations and can therefore be reproduced better.

A line technology established to date for MMICs is the microstrip line (microstrip). This line has an earth 30 metallization on the back. The lines and components are attached on the top.

During MMIC development, the individual parts of a circuit, such as amplifiers, mixers, couplers or power 35 splitters, are normally tested individually on their own. If such a radio-frequency circuit (or RF circuit) needs to be measured, then all the ports need to have been connected to the measurement device, such as a

radio-frequency probe or RF probe, or else to a termination, the unused ports needing to be terminated on a controlled reflection-free basis in radio-frequency technology. If these controlled reflection-5 free terminations have not already been implemented on the chip, however, it is difficult - particularly in the range of millimetre wavelengths - to terminate unterminated ports subsequently in a controlled fashion. In such a case in which the ports are 10 terminated subsequently, off-chip termination is referred to. Terminations which have already been implemented on the chip are referred to as on-chip terminations. Owing to the aforementioned drawbacks which arise when using off-chip terminations, it is 15 often preferred for the controlled, reflection-free terminations to be integrated on the chip previously, even though this relinquishes the flexibility which the off-chip terminations would allow. This is a drawback of the on-chip terminations terminated with the 20 required quality on a controlled reflection-free basis, because when using the on-chip terminations, that is to say when a permanent, integrated termination is used for the ports which are unused during measurement, every port termination which is required for a 25 measurement needs to have been implemented on the chip. This means that the same circuit needs to be placed on the test chip a number of times, because it requires different port terminations.

30 Although it is also possible to use a type of electronic on-chip switches, this option is rarely used because these non-linear switches entail another drawback in that a matched, reflection-free termination is likewise difficult to produce when they are used, 35 and also distortions are caused.

Advantages of the invention

The invention is therefore based on the object of developing an integrated circuit and a method for manufacturing same which overcome the aforementioned drawbacks, specifically with respect to material consumption and flexibility in the case of test passes for chip development and for chip manufacture, and which at the same time provide the respective matched reflection-free terminations which are required.

The invention achieves this object by virtue of the features in the characterizing part of Claims 1 and 11 in interaction with the features in the precharacterizing part. Expedient refinements of the invention are contained in the subclaims.

A particular advantage of the integrated circuit is that at least some of the ports and/or microstrip lines in the integrated circuit have a removable, reflection-free termination which is integrated on the chip.

A method for manufacturing an integrated circuit involves an integrated circuit being produced in a first step, with at least some of the ports and/or microstrip lines in the integrated circuit being provided with a removable, reflection-free termination which is integrated on the chip, and in a second step this termination being removed from a prescribable selection of the ports and/or microstrip lines provided with the removable, reflection-free termination which is integrated on the chip.

Another advantage of the invention is that the integrated circuit is in the form of an MMIC circuit. It is likewise found to be advantageous that the integrated circuit is in the form of a radio-frequency circuit.

One preferred embodiment of the inventive integrated circuit is that the integrated circuit is in the form of a test circuit.

5 It is also found to be advantageous that the ports in the integrated circuit are in the form of coplanar line ports.

10 Another advantage of the inventive integrated circuit is that the integrated circuit has at least one amplifier and/or one mixer and/or one coupler and/or one power splitter.

15 In one preferred embodiment of the invention, all the ports and/or microstrip lines in the integrated circuit have a removable, reflection-free termination which is integrated on the chip.

20 It is likewise found to be an advantage of the inventive circuit that input Lange couplers arranged on a chip have at least one port having a removable, reflection-free termination which is integrated on the chip.

25 Another advantage is that the removable, reflection-free terminations which are integrated on the chip are in the form of absorbing resistors.

30 It is also found to be advantageous that the removable, reflection-free terminations which are integrated on the chip are arranged symmetrically with respect to radio-frequency signal lines.

4

One preferred embodiment of the inventive method involves, in the first step of the method according to 35 Claim 11, all the ports and/or microstrip lines in the integrated circuit being provided with a removable, reflection-free termination which is integrated on the chip.

It is likewise found to be advantageous that absorbing resistors are used for the removable, reflection-free terminations which are integrated on the chip.

- 5 Another advantage of the inventive method is that the position and dimensions of removable, reflection-free terminations which are integrated on the chip are optimized for a reflection-free termination.
- 10 It can also be regarded as advantageous that the removable, reflection-free terminations which are integrated on the chip are arranged symmetrically with respect to radio-frequency signal lines.
- 15 Of advantage is a procedure in which the removable, reflection-free terminations which are integrated on the chip are removed by a laser.
- 20 It is also advantageous that the ports and/or micro-strip lines to be opened are selected in the second step of the method according to Claim 11 on the basis of the requirements of the measurement arrangements used for making contact with the radio-frequency connections.
- 25 In one preferred refinement of the inventive method, following removal of the removable, reflection-free terminations which are integrated on the chip, the ports and/or microstrip lines which are now open in the integrated circuit are connected to a measurement device. In this case, it is found to be advantageous that a radio-frequency connection is used as the connection to the measurement device.
- 30 35 In addition, in one preferred refinement of the inventive method, the measurement device is used to test individual parts of the integrated circuit, such as amplifiers, mixers, couplers and/or power splitters,

individually on their own.

It is likewise found to be an advantage that the removal of removable, reflection-free terminations 5 which are integrated on the chip stipulates properties of the integrated circuit.

In particular, in one preferred refinement of the inventive method, the removal of removable, reflection-free terminations which are integrated on the chip 10 stipulates the suppressed sideband of a mixer.

The invention provides a termination for radio-frequency ports (RF ports) which is integrated on the 15 chip and is suitable for making contact using a radio-frequency probe (RF probe). This makes it possible to save a large area on the "tile". The tile refers to the (limited) area which is available for designing new chips and can be used for test passes during 20 development work.

Whereas $n*(n-1)/2$ test objects were conventionally required for an n-port device, for example, precisely one test object is needed when employing the invention.

25 The invention can also be used to provide alternative radio-frequency ports on an MMIC circuit which are able to be opened selectively according to requirements while the rest of the ports are kept terminated. This 30 can be used advantageously not just when developing radio-frequency circuits but also when manufacturing these circuits, for example in order to select the suppressed sideband of a sideband mixer by virtue of one of the two ports of the input Lange coupler being 35 connected while the other is kept terminated.

Advantageous refinements of the invention can be found in the features cited in the subclaims.

Drawings

The invention will be explained in more detail below using an exemplary embodiment illustrated at least in 5 part in the Figures, in which:

Figure 1 shows a design for a conventional pad for radio-frequency probes (RF probe pad);

10 Figure 2 shows a design for an RF probe pad provided with removable terminations;

15 Figure 3 shows an attenuation curve to illustrate the transmission when the port is terminated for the purpose of checking the quality of the termination, and

Figure 4 shows an attenuation curve to illustrate the transmission when the termination has been removed by "lasering away".

20

Description of the exemplary embodiment

The exemplary embodiment of the invention will be illustrated below using the design of a coupler in a 25 radio frequency circuit. However, the invention can be used suitably not just for this specific example, but rather generally during chip development and also during manufacture, for example in order to select the top or bottom sideband for an integrated mixer.

30

To design new chips, there is generally only a limited area available - the "tile" or "recticle". The tile or recticle corresponds to the photomask, on which a plurality of different chip designs can be held. Of 35 this mask, a plurality are accommodated on the wafer, however. For this reason, a large number of identical chips are ultimately obtained from this design. To date, it has been necessary to accommodate a respective

coupler on the tile for each combination of the coupler's measurement ports which is to be rated. With the inventive method, precisely one embodiment of the coupler is needed. This then later likewise yields a 5 large number of copies whose ports can be opened differently, according to the requirements of the respective measurement. To date, for an n-coupler, if all combinations of ports (that is to say $n*(n-1)/2$) needed to be rated, a special coupler design would have 10 been needed for all these $n*(n-1)/2$ variants, which then also provide a large number of copies - generally more than are needed. Surface area is thus saved on the tile. This naturally also means that the end effect is that the corresponding chip area is saved.

15

To avoid the aforementioned drawbacks, particularly the need to implement the same circuit on the (test) chip a plurality of times, the invention proposes a removable, reflection-free termination for the ports which is 20 integrated on the chip.

The inventive removable termination can serve as a termination, by way of example, for microstrip lines 1 and/or coplanar line ports which can be opened in order 25 to permit a radio-frequency connection to the port. This means that a single circuit whose ports are respectively equipped with a removable, reflection-free termination which is integrated on the chip can be used for any measurement arrangements. Thus, the inventive 30 controlled termination suitable for making contact with RF connections reduces the area requirement on the tile, and hence ultimately also the chip area requirement, when carrying out test passes for development purposes. (In chip production, the chip area is 35 limited, whereas a wafer normally yields a plurality of identical chips). Generally, it is useful to have alternative RF ports available on an MMIC circuit in order to open them selectively, according to the

requirements of the respective measurement, while the rest of the ports are kept terminated. Likewise - as shown above using the example of sideband suppression for a sideband mixer - there are applications in chip 5 manufacture where the use of the invention is found to be advantageous, however.

In order to be able to open a port for the purpose of 10 making radio-frequency contact (RF probing), the inventive termination needs to be removed. This termination replaces the aforementioned electronic, non-linear switches and avoids the drawbacks thereof. In the case of the inventive removable, reflection-free 15 terminations which are integrated on the chip, the absorbing resistors 2 are cut away mechanically by a laser, so that finally a normal configuration is left for radio-frequency probing. When the resistor 2 has been removed by virtue of the resistor coating having 20 been "lasered away", such an RF port is open for contact to be made by a measurement arrangement.

For terminations of this kind, it is important for the RF port to be terminated in a really controlled manner when the termination has been added, while virtually 25 loss-free transmission needs to be ensured when the resistor 2 has been removed. The most difficult problem needing to be solved in this context is that of converting a normal radio-frequency contact into a good absorber merely by attaching a resistor 2 which 30 terminates in a controlled manner.

Figure 2 shows an example of such an absorber. In this case, the MMIC substrate is shown in plan view; the underside of the MMIC substrate has been metallized and 35 serves as "ground". In addition, Figure 2 shows the position markers 3 which are normal for a connection for radio-frequency probes but can also be dispensed with. The pads for making RF contact 4 are connected to

the underlying ground through the via holes 5. While the metal form of the pads for making RF contact 4 is identical to those for a conventional connection for making RF contact 4 (cf. Figure 1), two resistors 2 are 5 arranged symmetrically with respect to the RF signal line. In this case, the position and dimensions of the resistors 2 have been optimized in order to produce the controlled termination, as can be seen in Figure 3. The transmission when the termination has been removed is 10 shown in Figure 4. In this case, a small amount of attenuation arises which is typically 0.1 dB to 0.3 dB and is caused as a result of a slight conductivity in the substrate material when the resistors 2 have been removed by a laser. For the purposes of the 15 measurements which are to be performed, this RF connection is sufficient, however.

The typical measurement for a multiport proceeds as follows:

20

For each tile - that is to say on the limited design area - there is a coupler design, for example, where all the ports have been terminated using the inventive removable, reflection-free termination which is 25 integrated on the chip. However, many, for example m , chips are obtained with this one design, in which case the conventional method would be used to obtain m times $n*(n-1)/2$ couplers. This is in contrast to what is now only m copies.

30

For every combination of measurement ports which is to be rated, the corresponding inventive terminations are removed from at least one copy in each case, so that the necessary $n*(n-1)/2$ measurement objects are 35 obtained as a result.

The formula $n*(n-1)/2$ is obtained as follows:

Example: 4-port coupler:

For this, six combinations are required:

5 Port 1 <---> Port 2
 Port 1 <---> Port 3
 Port 1 <---> Port 4
 Port 2 <---> Port 3
 Port 2 <---> Port 4
 Port 3 <---> Port 4

10 With a large number of real couplers, this number is reduced by symmetries, however, but two designs would nevertheless be needed at least.

15 The invention is not limited to the exemplary embodiments illustrated in the present case. Instead, it is possible to produce other variant embodiments by combining and modifying the said means and features, without departing from the scope of the invention.

Patent Claims

1. Integrated circuit having at least one microstrip line and at least one port, characterized in that at least some of the ports and/or microstrip lines (1) in the integrated circuit have a removable, reflection-free termination which is integrated on the chip.
2. Integrated circuit according to Claim 1, characterized in that the integrated circuit is in the form of an MMIC circuit.
3. Integrated circuit according to one of the preceding claims, characterized in that the integrated circuit is in the form of a radio-frequency circuit.
4. Integrated circuit according to one of the preceding claims, characterized in that the integrated circuit is in the form of a test circuit.
5. Integrated circuit according to one of the preceding claims, characterized in that the ports in the integrated circuit are in the form of coplanar line ports.
6. Integrated circuit according to one of the preceding claims, characterized in that the integrated circuit has at least
 - one amplifier and/or
 - one mixer and/or
 - one coupler and/or
 - one power splitter
7. Integrated circuit according to one of the preceding claims, characterized in that all the ports and/or microstrip lines (1) in the integrated circuit

have a removable, reflection-free termination which is integrated on the chip.

8. Integrated circuit according to Claim 6,
5 characterized in that input Lange couplers arranged on a chip have at least one port having a removable, reflection-free termination which is integrated on the chip.

10 9. Integrated circuit according to one of the preceding claims, characterized in that the removable, reflection-free terminations which are integrated on the chip are in the form of absorbing resistors (2).

15 10. Integrated circuit according to one of the preceding claims, characterized in that the removable, reflection-free terminations which are integrated on the chip are arranged symmetrically with respect to radio-frequency signal lines.

20 11. Method for manufacturing an integrated circuit, characterized in that an integrated circuit is produced in a first step, with at least some of the ports and/or microstrip lines (1) in the integrated circuit being provided with a removable, reflection-free termination which is integrated on the chip, and in a second step this termination is removed from a prescribable selection of the ports and/or microstrip lines 1 provided with the removable, reflection-free 30 termination which is integrated on the chip.

12. Method according to Claim 11, characterized in that, in the first step of the method according to Claim 11, all the ports and/or microstrip lines (1) in the integrated circuit are provided with a removable, reflection-free termination which is integrated on the chip.

13. Method according to one of Claims 11 or 12, characterized in that absorbing resistors (2) are used for the removable, reflection-free terminations which are integrated on the chip.

5

14. Method according to one of Claims 11 to 13, characterized in that the position and dimensions of removable, reflection-free terminations which are integrated on the chip are optimized for a reflection-free termination.

10

15. Method according to one of Claims 11 to 14, characterized in that the removable, reflection-free terminations which are integrated on the chip are arranged symmetrically with respect to radio-frequency signal lines.

15
20

16. Method according to one of Claims 11 to 15, characterized in that the removable, reflection-free terminations which are integrated on the chip are removed by a laser.

25

17. Method according to one of Claims 11 to 16, characterized in that the ports and/or microstrip lines (1) to be opened are selected in the second step of the method according to Claim 11 on the basis of the requirements of the measurement arrangements used for making contact with the radio-frequency connections.

30
35

18. Method according to one of Claims 11 to 17, characterized in that, following removal of the removable, reflection-free terminations which are integrated on the chip, the ports and/or microstrip lines (1) which are now open in the integrated circuit are connected to a measurement device.

19. Method according to one of Claims 11 to 18, characterized in that a radio-frequency connection is

used as the connection to the measurement device.

20. Method according to one of Claims 11 to 19, characterized in that the measurement device is used to test individual parts of the integrated circuit, such as amplifiers, mixers, couplers and/or power splitters, individually on their own.
- 10 21. Method according to one of Claims 11 to 20, characterized in that the removal of removable, reflection-free terminations which are integrated on the chip stipulates properties of the integrated circuit.
- 15 22. Method according to one of Claims 11 to 21, characterized in that the removal of removable, reflection-free terminations which are integrated on the chip stipulates the suppressed sideband of a mixer.

1 / 2

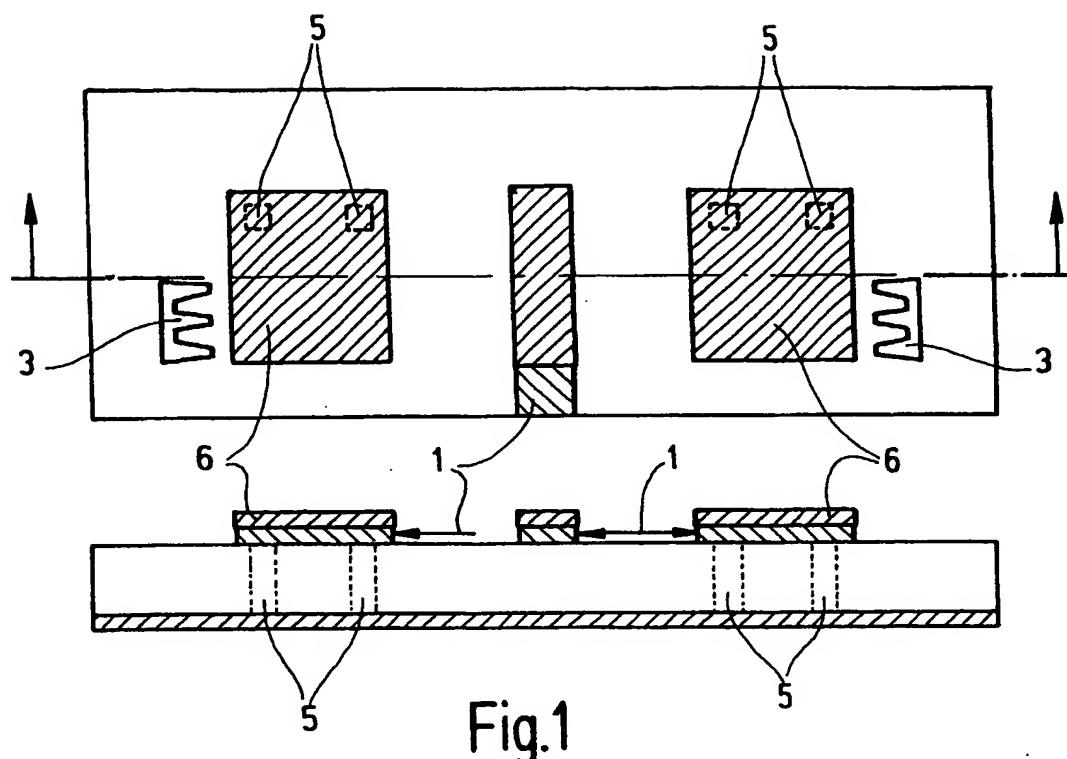


Fig.1

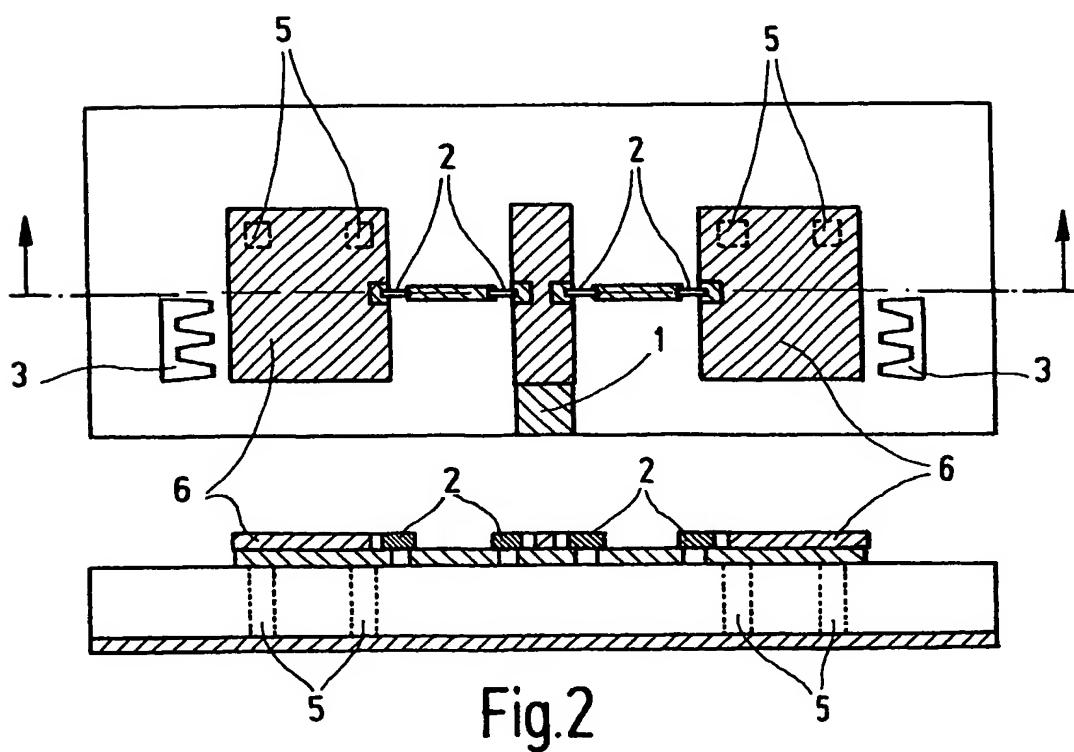


Fig.2

2 / 2

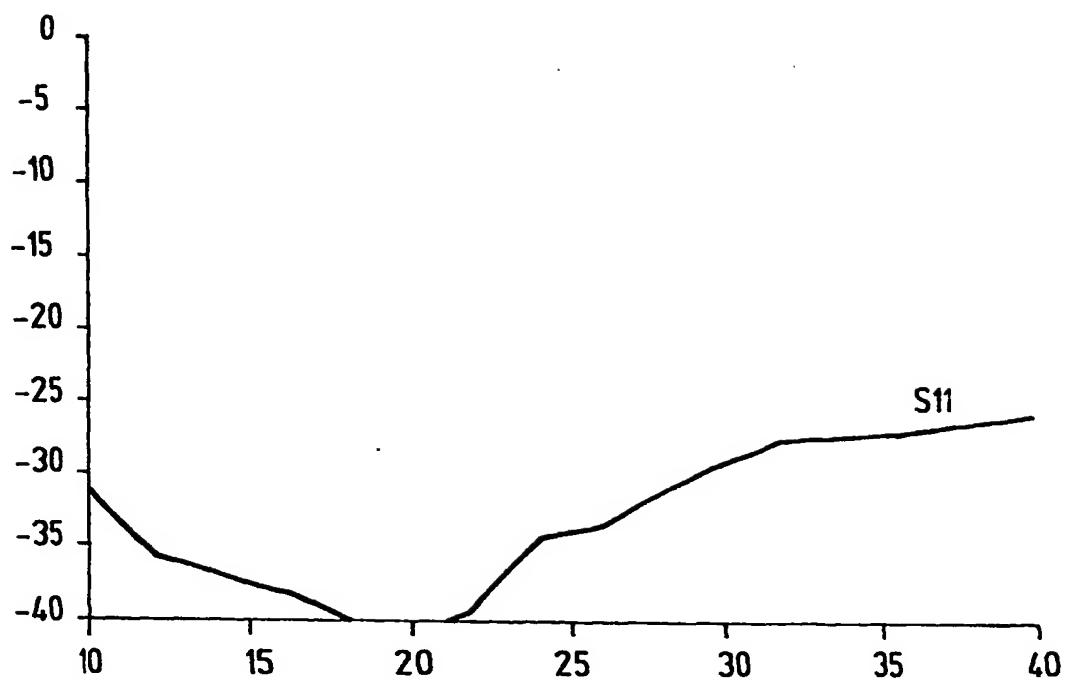


Fig.3

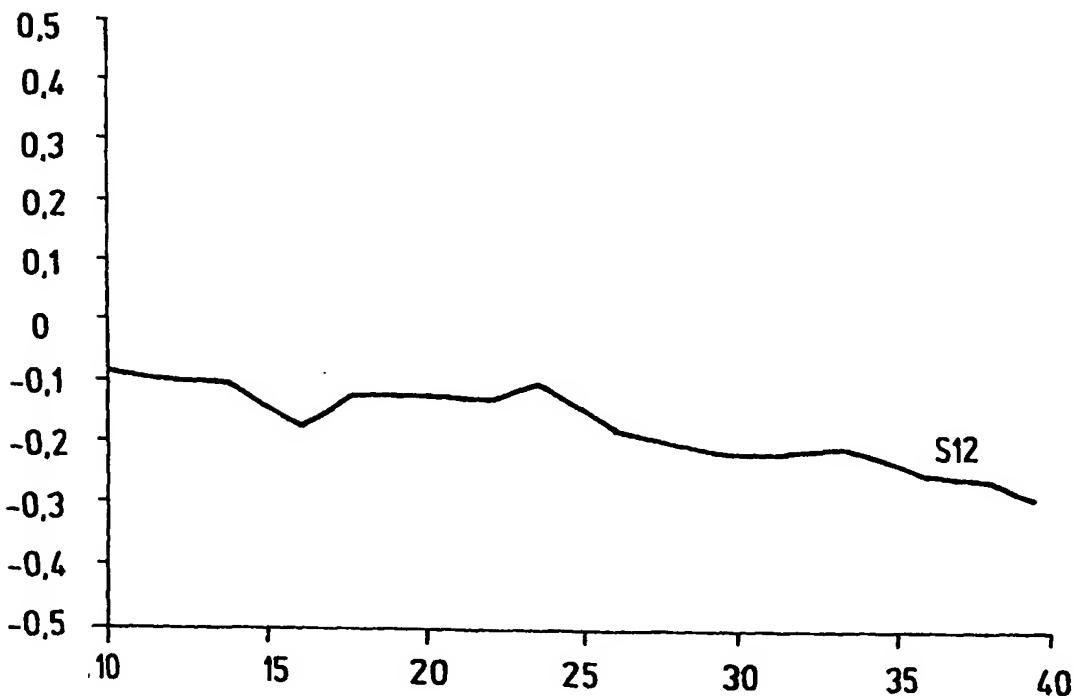


Fig.4

(19) World Intellectual Property Organization International Bureau



(43) International Publication Date
18 December 2003 (18.12.2003)

PCT

(10) International Publication Number
WO 2003/105186 A3

(51) International Patent Classification⁷: H01P 1/26, G01R 27/32

(74) Agent: CAMP, Ronald; Marconi Intellectual Property, Marrable House, The Vineyards, Great Baddow, Chelmsford, Essex, CM2 7QS (GB).

(21) International Application Number:

PCT/IB2003/002712

(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(22) International Filing Date: 27 May 2003 (27.05.2003)

(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

(25) Filing Language: English

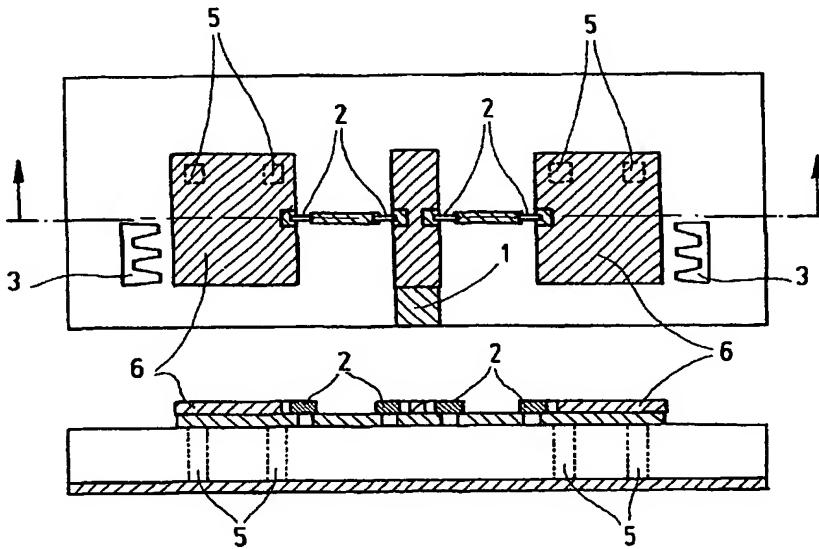
(26) Publication Language: English

(30) Priority Data: P.10225042.1 6 June 2002 (06.06.2002) DE

Published:
— with international search report

[Continued on next page]

(54) Title: INTEGRATED CIRCUIT AND METHOD FOR MANUFACTURING SAME



WO 2003/105186 A3

(57) Abstract: The invention relates to an integrated circuit having at least one microstrip line and at least one port, and to a method for manufacturing same, these being able to be used, in particular, for test passes for development purposes during chip production and also during chip manufacture. The invention provides for at least some of the ports and/or microstrip lines (1) in the integrated circuit to have a removable, reflection-free termination which is integrated on the chip. The inventive method provides for an integrated circuit to be produced in a first step, with at least some of the ports and/or microstrip lines (1) in the integrated circuit being provided with a removable, reflection-free termination which is integrated on the chip, and in a second step for this termination to be removed from a prescribable selection of the ports and/or microstrip lines (1) provided with the removable, reflection-free termination which is integrated on the chip.



(88) Date of publication of the international search report:
21 May 2004

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

Inten

Application No

PCT/IB 03/02712

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H01P1/26 G01R27/32

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H01P G01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2002/000894 A1 (TANIZAKI TORU ET AL) 3 January 2002 (2002-01-03) paragraphs '0081!, '0094!; figure 6	1-22
Y	EP 0 622 840 A (NIPPON ELECTRIC CO) 2 November 1994 (1994-11-02) column 10, line 40 - column 11, line 12; figures 5A,5B,5C,6A,6B,6C	1-22
X	WO 02/12916 A (RAYTHEON CO) 14 February 2002 (2002-02-14) page 11, line 22 - line 29; figure 1	1,3,4,9, 11,13, 14, 17-19,21
A	EP 1 093 181 A (MURATA MANUFACTURING CO) 18 April 2001 (2001-04-18) paragraph '0048!; figure 8	1
		-/-

 Further documents are listed in the continuation of box C. Patent family members are listed in annex.

* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

& document member of the same patent family

Date of the actual completion of the International search

Date of mailing of the International search report

29 January 2004

16/02/2004

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl
Fax: (+31-70) 340-3016

Authorized officer

La Casta Muñoa, S

INTERNATIONAL SEARCH REPORT

Intel Application No
PCT/IB 03/02712

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	D'AGOSTINO S ET AL: "Design of high performance power distributed amplifier using Lange couplers" MICROWAVE SYMPOSIUM DIGEST, 1994., IEEE MTT-S INTERNATIONAL SAN DIEGO, CA, USA 23-27 MAY 1994, NEW YORK, NY, USA, IEEE, 23 May 1994 (1994-05-23), pages 281-284, XP010120537 ISBN: 0-7803-1778-5 the whole document -----	1-4,8,9
A	EP 0 424 536 A (FUJITSU LTD) 2 May 1991 (1991-05-02) figures 8,10 -----	10

INTERNATIONAL SEARCH REPORT

Intel. Application No.
PCT/IB 03/02712

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US 2002000894	A1 03-01-2002	JP 3287309 B2 JP 2000022410 A US 2002186095 A1 EP 0971435 A2 US 6285266 B1		04-06-2002 21-01-2000 12-12-2002 12-01-2000 04-09-2001
EP 0622840	A 02-11-1994	JP 2099536 C JP 6296106 A JP 8021807 B AU 667769 B2 AU 5933894 A CA 2120804 A1 DE 69425775 D1 DE 69425775 T2 EP 0622840 A2 US 5396433 A		22-10-1996 21-10-1994 04-03-1996 04-04-1996 13-10-1994 08-10-1994 12-10-2000 01-02-2001 02-11-1994 07-03-1995
WO 0212916	A 14-02-2002	US 6498582 B1 CA 2418092 A1 EP 1309884 A1 WO 0212916 A1		24-12-2002 14-02-2002 14-05-2003 14-02-2002
EP 1093181	A 18-04-2001	JP 2001185912 A EP 1093181 A2 CN 1303138 A		06-07-2001 18-04-2001 11-07-2001
EP 0424536	A 02-05-1991	DE 69012501 D1 DE 69012501 T2 EP 0424536 A1 WO 9009040 A1 JP 7048606 B US 5151676 A CA 2026574 A1		20-10-1994 09-03-1995 02-05-1991 09-08-1990 24-05-1995 29-09-1992 03-08-1990